The optimisation of nickel extraction with the use of supported liquid membrane capsules

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Abstract

In a previous publication the authors described the investigation and characterisation of a new approach to supported liquid membranes, whereby the strip solution is encapsulated within a microporous membrane capsule. The research in this article is a continuation of the earlier article and focuses on the influence of the hydronium ion concentration of the strip solution on the extraction of nickel, as well as the influence of temperature, agitation and ligand enhancement on the extraction process. The optimum conditions for the extraction of nickel with the use of capsuled membrane extraction were determined. Extraction of approximately 109 g/m² was obtained at an initial rate of 44.7 g/m²h. It was estimated that the membrane capsules would have to be recycled at least 14 times to break even under current economic conditions.

Abbreviations

AA	Atomic absorption spectrophotometer
A_{mem}	Area of membrane capsule
Cir_{mem}	Circumference of membrane capsule
D	Impeller diameter (m)
D2EHPA	Di-2(ethylhexyl) phosphoric acid
Ex	Extractant
Extr	Extraction of nickel
Rate	Rate of nickel extraction
SLM	Supported liquid membranes
CME	Capsuled membrane extraction
u	Viscosity (N s/m²)
p	Density (kg/m³)
co	Rate of rotation

Introduction

In an earlier publication (Smit and Koekemoer, 1996) a new approach to supported liquid membranes was described, whereby the strip solution is encapsulated within a microporous membrane capsule. In that publication the research had been focused on the extraction of nickel at high hydronium strip concentrations, which is a major advantage of CME over SLM. This led to a better understanding of this extraction method, but certain questions still remained, e.g.:

- What is the optimum hydronium ion concentration for the strip solution?
- What is the influence of temperature on the extraction of nickel with CME?
- What is the influence of feed solution agitation on the extraction of nickel with CME?
- Will different anion ligands enhance the extraction of nickel with CME?

The research in this article was focused on answering these questions and on finding the optimum conditions for the extraction of nickel with the use of CME. Such optimisation should facilitate the determination of the techno-economic feasibility of this extraction technique.

Experimental

The membrane capsule

A membrane in capsule configuration was used for the experiments (Erlank, 1984). The membrane was folded double and a hot wire sealer was used to seal all the edges, except one. The capsule was then impregnated by leaving the capsule in the extractant and allowing the extractant to permeate into the membrane pores. The excess extractant (on the outside) was removed by blotting. The capsule was filled with strip solution at the open edge and then completely sealed. The capsules varied in size, but had an average diameter of approximately 40 mm (Fig. 1). The average contact area of a membrane capsule was approximately 26 cm². A string was used to keep the capsule suspended in the bulk aqueous feed solution (cf. Photograph 1). It was vital that the sealed edges of the capsule did not leak since that would defeat the integrity of the extraction system. The membrane used for the experiments was Celgard® 4510 film, manufactured by Celanese Separations Products. Di-2(ethylhexyl) phosphoric acid (D2EHPA) was used as an extractant.

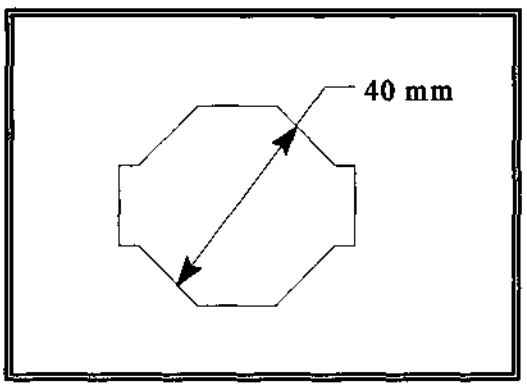

Figure1
Diagram of membrane capsule

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